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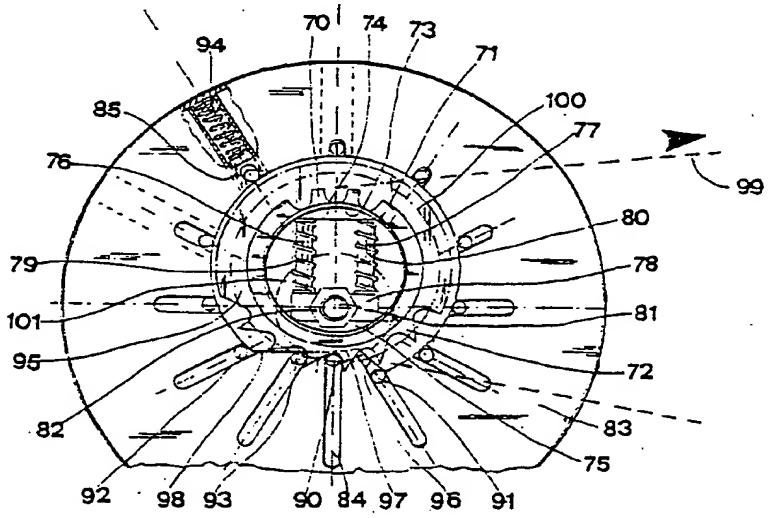

(57) Abstract

Continuous speed change gear, especially for two-wheeled vehicles, comprising two cog wheels (72), (83), means for continuously varying, as desired, their center distances, accompanied by radial translation of the cogs (90) of one (83) of the two wheels, means (95) for allowing the wheels to mesh practically with one cog (90) at a time and at least with one cog of the wheel (83) with translatable cogs, so that, with each variation of the center distance there will be continuous variation of the ratio of transmission between the axles of the two wheels (72), (83).

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CONTINUOUS SPEED GEAR FUNCTIONING BY MEANS OF COG WHEELS WITH COGS OF VARIABLE RADIUS

Gears for speed changing, namely devices used to vary the speed of transmission between a drive shaft and a driven shaft , are well known.

Speed variation may be made by mating cog wheels fitted with differing numbers of cogs, or by friction systems such as moving transmission belts over bevel gears.

In the first case a high level of efficiency, and high degree of precision are obtained as only rolling friction is determined, but variation is uneven and needs compensating devices such as the clutch in automobile vehicles.

In the second case, as a consequence of the sliding friction necessary between driving and driven parts, much efficiency is lost, parts wear out quickly and operation is irregular.

Specifically in the field of cycles and motorcycles, speed change is made by moving the transmission chain over from one cog wheel to another, using devices which are both complex and delicate.

The types of speed change devices with gears inside the hub have complex structures and are therefore both bulky and costly.

The above invention eliminates these drawbacks and offers considerable advantages as will be described below.

Subject of the invention is a continuous speed change gear applicable to two-wheeled vehicles in particular, comprising a pair of cog wheels, means for continuous variation, as desired, of their center distances accompanied by a radial translation of the cog of at least one of the pairs of wheels in relation to said variation, means for allowing the two wheels to mesh practically with one cog only, and at least with one cog at a time, on the wheel with translatable cogs.

Therefore, by varying the pitch circle of at least one

of the two wheels of each pair, it is possible to obtain continuous variation of their ratio of transmission to the desired value.

The wheel with fixed cogs is placed inside the toothing, facing towards its center, of the wheel with translatable cogs.

In one type of execution the means for varying the center distance between the two wheels of each pair comprise a cylindrical support, translatable in the direction of one of its diameters, around which the wheel with fixed cogs can turn freely.

A circular coaxial cam is fixed to the translatable cylindrical support of the wheel with fixed cogs, having a diameter greater than the external circumference of said wheel but having a lower portion of the circumference, with a smaller radius, passing in the base of the groove between the cogs of said wheel, the beginning of said lower portion being marked by a step then continuing by a join portion to regain the maximum circumference.

The maximum diameter zone of the cam prevents meshing between the two wheels of each pair while the lower zone, when a cog on the wheel with translatable cogs presents itself, permits quick meshing with a groove in the wheel of fixed cogs followed by expulsion of the translatable cog to allow the following one to mesh.

In one kind of execution cogs on the wheel with fixed cogs are saw type.

In one kind of execution the wheel with translatable cogs consists of a disk in which there are radial slots and along these sliders move, having outwardly projecting cogs pushed towards the center of the wheel by elastic means.

The invention includes means for automatically varying the ratio of transmission with variation of the load.

Said means essentially consist of movement mechanisms for

setting up components of forces generated by the load opposing the forces of reaction set up by the elastic means.

Therefore, as the load varies, according to whether said components overcome the forces of reaction or are overcome by them, a gradual variation takes place in the center distance between the wheels of each pair such as will respectively reduce or multiply the ratio of transmission.

In one type of execution the wheel with translatable cogs is fixed to the back wheel of a bicycle, or similar vehicle, while the chain that transmits pedal crank movement is applied to a sprocket wheel fixed to the wheel with fixed toothing.

The cylindrical support of the latter wheel can translate on runners fixed to the pin of the bicycle's back wheel.

Said translatable support is driven by a special system of levers or by an automatic means sensitive to variations in the load.

In one type of execution the automatic means essentially consists of springs or of elastic means generally, placed between a bridge fixed to the pin of the bicycle's back wheel and a plane situated on the cylindrical support of the wheel with fixed cogs.

Said springs tend to push the cog wheel upwards, and therefore its meshing zone as well situated below the center of rotation of the wheel with translatable cogs. The downward component of the forces created by chain pull, when a certain value is exceeded, therefore overcomes spring reaction causing the meshing zone to move gradually towards the outer edge of the wheel with translatable cogs, progressively reducing the ratio of transmission.

The characteristics and purposes of the invention will be made even clearer by the following examples of its execution illustrated by drawings.

Fig. 1 The speed change gear seen from the front.

Fig. 2 An exploded view of the speed change gear.

Fig. 3 The speed change gear as it is when ratio of transmission is highest.

Fig. 4 The speed change gear in another phase of its movement.

Fig. 5 The speed change gear mounted on a bicycle, seen partially.

Fig. 6 Partial back view of the bicycle in Fig. 5.

Fig. 7 Gear with hook-shaped cogs.

Fig. 8 Gear mounted on a bicycle, with automatic variation of the ratio of transmission according to the load, front view.

Fig. 9 The gear in Fig. 8 as it is when load is greatest.

Fig.10 The gear for fixed installations, side view.

The gear (10) comprises a cylindrical ring (11) rotating freely on a cylindrical support (12) by means of a roller bearing (13).

Sprocket wheel (14) and cog wheel (15) are fixed to the ring (11). The circular, coaxial cam (17) is fixed to the support (12), cam diameter being greater than that of the outer circumference of the cog wheel (15), the cam being adjacent to said wheel though allowing it to rotate freely.

In Fig. 1 the sprocket wheel (14) is not seen to allow a view of the cog wheel (15).

The group formed by the ring (11), the support (12) and the cam (17) is adjacent to the cog wheel (16) rotating on the shaft (18), the cogs of said wheel consisting of cylindrical pins (19), (20), (21), (22) fixed to sliding means, omitted for simplicity in the figures, radially translatable in the radial slots (23), (24), (25), (26).

The elastic ring (35) pushes the translatable cogs (19-22) towards the axle of the wheel (16).

The support (12) and the cam (17) respectively present diametral slots (27), (28), of practically the same amplitude, through which the shaft (18) of wheel (16) passes

freely.

In the cam (17) there is a lower arched zone (3C), whose radius is less than the radius of the circumference passing through the bottom of the groove (32) between the cogs of the cog wheel (15), said zone beginning with a step (29) and terminating by a join portion (31) that regains the maximum circumference.

Means not shown permit and guide translation of the support (12) together with the cam (17) along the XX axis of the above mentioned slots (27), (28) fixing them in the position corresponding to the desired ratio of transmission.

In Fig. 1 the ratio of transmission is 1:1 as shown by coincidence of the pitch circle (33) of the cog wheel (15) with pitch circle (34) of wheel (16).

By making the support (12) translate to the position in Fig. 3, the pitch circle (34) of the wheel (16) becomes (34') and the ratio of transmission about 2:1.

Due to the pull exerted by the chain (36) on sprocket wheel (14), fixed to cog wheel (15) by the ring (11), Fig.2, in rotating this latter wheel drags wheel (16) into rotation by means of the cog (19).

During the movement this latter cog, rising to that part of the cam (17) fixed to support (12), emerges from the groove in the opposing cogs while cog (20), passing beyond the step (29) cut in the cam (17), moves into the lowered zone (30), fitting into a fresh groove in the cog (15) and taking the place of cog (19).

By continuing the movement a fresh cog (22) will take the place of cog (20), and so on.

It is clear that a different position assumed by the support (12) in relation to the wheel (16) will vary the ratio of transmission. For example, by moving the support (12) to a position opposite, in relation to the shaft(18), that shown in Fig. 3, and that is upwards, the ratio of transmission will be about 3:4 as appears in Fig. 3 from

the corresponding pitch circle (34') and from the pitch circle (33') of the c o g wheel (15) whose diameter remains constant.

Figures 5 and 6 show how the speed change (10), already described, is applied to a bicycle (40), its back wheel (41) being supported by the fork (42) and pin (43) with threading (44) and bolts (45).

The wheel (16) is fixed to the hub (46) of the bicycle wheel (41) while the support (12) is fixed to the fork (42), by means omitted for simplicity, in the position corresponding to the desired ratio.

The sprocket wheel (14) is connected, by means of a chain (50), to the sprocket wheel (47) fixed to the pedal crank (48).

Using means omitted for simplicity, the rider of the vehicle can, by moving the support (12) in relation to the shaft (43), gradually and continuously vary the ratio of transmission.

Figure 7 illustrates a variant which consists in adoption of a cog wheel (51), having saw teeth (52), fixed to a ring (53) able to rotate freely on the support (12') equivalent to that in the preceding figures, on roller means (54).

Said c o g wheel (51) meshes with the cogs of the wheel (55) whose translation is similarly controlled by the cam (17'). Said cogs are formed of pins (56) mounted onto sliding means, omitted in the figure, which slide in the slots (57), each pin being supplied with a hook (59) held against the c o g wheel (51) by springs.

The c o g wheel (58) for chain transmission, as indicated by a dotted line, is fixed to the ring (53).

This variant makes it possible to "freewheel" the vehicle. The elastic ring (35') pushes the pins (56) towards the center of the wheel (55).

Figures 8 and 9 illustrate an application particularly

suitable for bicycles and motorcycles, but also clearly suited to a great many other applications as well.

The sprocket wheel (70) is fixed to the saw-toothed wheel (72) by means of the ring (71).

Said ring can rotate freely in relation to the cylindrical support (73) comprising the counterposed planes (74),(75) for the parallel columns (76), (77) on which the bridge (78) slides.

Rotation takes place on a bearing,placed coaxially to the saw-toothed wheel (72),said bearing being invisible as it is covered by the wheel (70) of smaller diameter.

Compression springs (79), (80) are mounted between the bridge (78) and the support (74).

The bridge (78) can be applied by bolts (82) to the threaded end of the shaft (81) supporting the back wheel of the bicycle.

The discoid wheel (83) rotates freely round the shaft (81) and is fixed to the back wheel of the bicycle.

It follows from the foregoing that the two wheels (72),(83) realize the variable ratio of transmission continuously in the same way as the counterposed cog wheels (15),(16) do in the first example described (Figures 1 - 4).

Clearly visible in the wheel (83) are the radial slots(84) in which the cogs (90), (91), (92), (93),and others, move pushed by compression springs, like (94).

Cam (95, substantially similar to cam (17) in the preceding examples, comprises the step (96) and zone (97) of a radius small than the radius of the circumference passing through the grooves of the saw-toothed wheel (72).

By means of the pedal crank and related sprocket wheel, omitted from the figure, and by means of the chain (99), the wheel (70) is drawn in the direction indicated by the arrows, drawing in turn the saw-toothed wheel (72) on which the radially translating cogs of wheel (83) engage one after the other causing said wheel (83) to rotate and, with it,

the bicycle wheel fixed to said wheel (83).
During the movement cog (90) leaves the groove in the saw-toothed wheel due to the effect exerted on it by the cam, and is replaced by cog (91) while cog (92), passing the join portion (98), moves onto the maximum diameter circumference of the cam concerned, and so on for cog (93) and the following ones.

Figure 8 illustrates a transmission ratio, between the c o g wheel (72) and the wheel (83), equivalent to about 2:1, corresponding to the ratio between the pitch circle (100) of the c o g wheel (72) and the pitch circle (101) relative to an engaged cog such as cog (90).

If the bicycle is being ridden uphill the load on the chain (99) obviously increases and therefore a downward force component is created that tends to push the support (73) downwards as well, progressively compressing the springs(79),(80).

At maximum load (Fig. 9) the transmission ratio wil depend on the ratio between the pitch circle (100) of the c o g wheel (72) and the pitch circle (101') corresponding to the engaged cog (90).

Said variation in ratio will be automatic, continuous and in relation to the variation in the load.

Fig. 10 shows an example of how the speed change already described, especially the one illustrated in Figures 1 - 6, can be used in a fixed installation.

The base (110) supports the frame (111) with bearings (112), (113) for the shaft (114) to which the wheel (118) with radially translating cogs substantially the same as the wheel (16) in the previous example, is fixed.

In said wheel (118) the radial slots support the cogs such as (117), (117') which, one after another, engage the cog wheel (115) fixed to the ring (119) to which the c o g wheel (120) is also fixed and is suitable for being driven, by means of a chain, by a drive shaft.

With interposed ball bearing, the ring (119) is supported by the cylindrical body (121) to which the cam (122) is fixed, said cam being practically the same as the cam (17) already described in the preceding example.

Also fixed to said body (121) supported by the column(127) on the base (110) allowing said body to translate vertically, is the vertical rack (123) into which the toothed arc (124), turning round the horizontal shaft (125) and fitted with a manoeuvering lever (126), engages.

Acting on the lever (126), translation may be obtained of the body (121) and therefore variation of the ratio of transmission between the drive shaft and the driven shaft (114).

In all the great many forms of execution possible, the advantages of cog wheel speed change gears can be obtained, as regards sure and precise transmission and efficiency, and the advantages of friction speed change gears as regards continuity in variation of the ratio.

The possibility of obtaining automatic variation of the ratio in accordance with the variation of loads, also ensures further very considerable advantages in some applications like those already explained, for cycles and motorcycles.

Since the applications of the invention have been described as examples only not limited to these, it is understood that every equivalent application of the inventive concepts explained and any product executed and/or in operation according to the characteristics of the invention, will be covered by its field of protection.

Claims

1. Continuous speed gear, especially for two-wheeled vehicles, characterized in that it comprises a pair (15-16), 72-83), (115-118) of cog wheels, means (12), (73),(121) of continually varying their center distances, as desired, accompanied by radial translation of the cogs (19), (90), (117), of at least one (16), (83), (118) of the two wheels in relation to said variation, means (17), (95), (122) for allowing meshing of the two wheels practically with one cog (19), (90), (117) at a time and at least with one cog of the wheel (16), (83), (118) with translatable cogs to obtain, by varying the pitch circle of at least one of the two wheels of each pair (15-16), (72-83), (115-118), continuous variation of their ratio of transmission to the desired value.

2. Continuous speed gear, especially for two-wheeled vehicles, as in claim 1, characterized in that the wheel (15), (72), (115) with fixed cogs is placed inside the toothing, turned towards its center, of the wheel (16),(83), (118) with translatable cogs (19), (90), (117).

3. Continuous speed gear, especially for two-wheeled vehicles, as in claim 1, characterized in that the means for varying the center distance between the two wheels of each pair (15-16), (72-83), (115-118) comprise a cylindrical support (12), (73), (121), translatable in the direction of one of its diameters, around which the wheel (15), (72), (115) with fixed cogs can rotate freely.

4. Continuous speed gear, especially for two-wheeled vehicles, as in claim 3, characterized in that a circular coaxial cam (17), (95), (122) is fixed to the cylindrical translatable support (12), (73), (121) of the wheel (15), (72), (115) with fixed cogs, said cam having a diameter greater than that of the external circumference of said wheel (15), (72), (115) but having a lower zone (30),(97) of a radius less than the radius of the circumference passing through the bottom of the groove between the cogs

of said wheel, said lower zone beginning with a step (29), (97) and terminating with a join portion (31), (98), the maximum diameter zone of the cam preventing meshing between the two wheels of each pair (15-16), (72-83), (115-118), but the lower zone, when a translatable cog (19), (90), (117) on the wheel (16), (83), (118) with translatable cogs, presents itself, allowing quick meshing with a groove in the wheel (15), (72), (115) with fixed cogs, followed by expulsion to permit meshing with a successive translatable cog (20), (91).

5. Continuous speed gear, especially for two-wheeled vehicles, as in claim 1, characterized in that the toothing of the wheel (72) with fixed cogs is of the saw type.

6. Continuous speed gear, especially for two-wheeled vehicles, as in claim 1, characterized in that the cogs (19), (90), (117) of the wheel (16), (83), (118) with translatable cogs, are pushed towards its center by elastic means (35), (94).

7. Continuous speed gear, especially for two-wheeled vehicles, as in claim 1, characterized in that the wheel (16), (83), (118) with translatable cogs consists of a disc comprising radial slots (23), (84) in which sliding means (85) slide, carrying outwardly projecting cogs (19), (90), (117) pushed towards the center of the wheel by elastic means.

8. Continuous speed gear , especially for two-wheeled vehicles, as in claim 1, characterized in that means are provided for automatically varying the ratio of transmission as the load varies, said means essentially consisting of movement mechanisms (73), (74), (75), (76), (77), (78) that create components of the forces generated by the load opposed to the forces of reaction set up by elastic means (79), (80), so that, as the load varies, according to whether said components overcome the forces of reaction or are overcome by them, a gradual variation takes

place in the center distance between the wheels of each pair (15-16), (72-83), (115-118) such as respectively to reduce or multiply their ratio of transmission.

9. Continuous speed gear, especially for two-wheeled vehicles as in claims 1 and 2, characterized in that the wheel (16), (83) with translatable cogs (19), (90) is mounted on the back wheel (41) of a bicycle (40) and similar vehicles, while the chain (50), (99) that transmits the movement created by the pedal crank is applied to a sprocket wheel (14), (70) fixed to the wheel (15), (72) with fixed cogs, the cylindrical support (12), (73) of this latter wheel (15), (72) being able to translate on runners (76), (77) fixed to the pin (44), (81) of the back wheel (41) of the bicycle (40), said support (12), (73) being controlled by a special system of levers or by automatic means sensitive to variations in the load.

10. Continuous speed gear, especially for two-wheeled vehicles as in claim 9, characterized in that the automatic means consists essentially of springs (79), (80) or elastic means generally, situated between a bridge (78) fixed to the pin (81) of the back wheel of a bicycle, and a plane (74) situated on the cylindrical support (73) of the wheel (72) with fixed cogs , said springs (79), (80) tending to push upwards the cog wheel (72) and therefore its meshing zone placed below the center of rotation of the wheel (83) with translatable cogs (90) so that the downward component of the forces created by the pull exercized by the chain 99, when a certain value is exceeded , overcomes the reaction of the springs (79), (80) bringing about passage of the meshing zone towards the periphery of the wheel (83) with translatable cogs (90), progressively reducing the ratio of transmission.

fig. 1

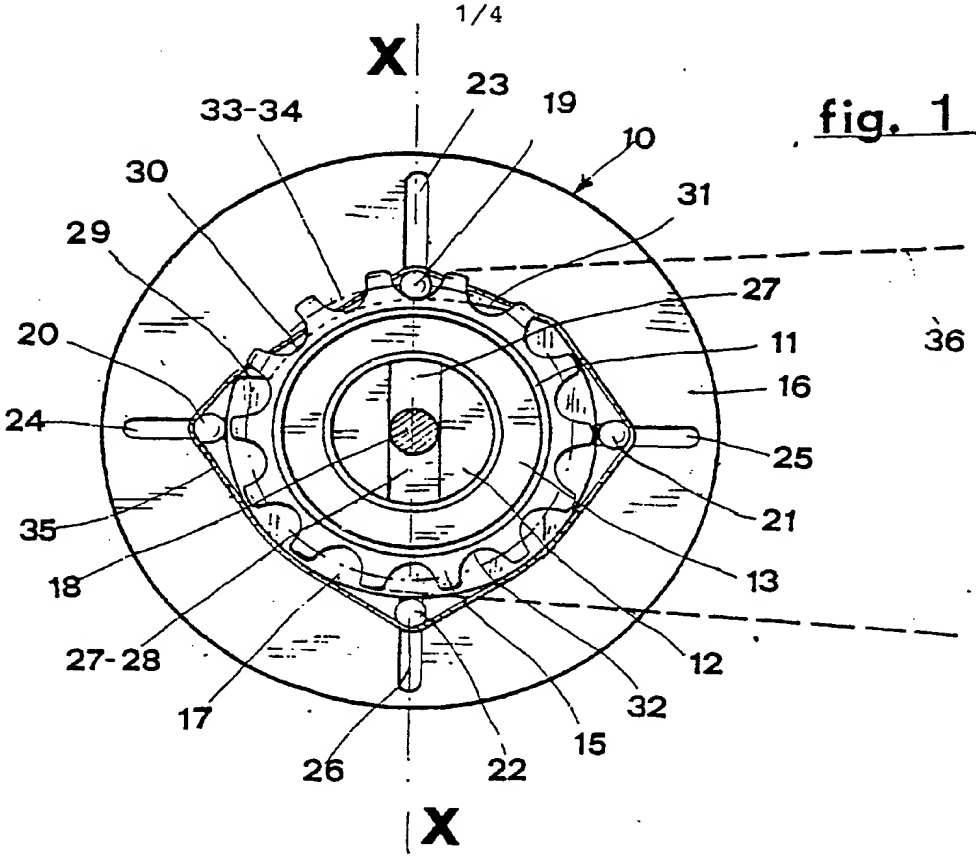
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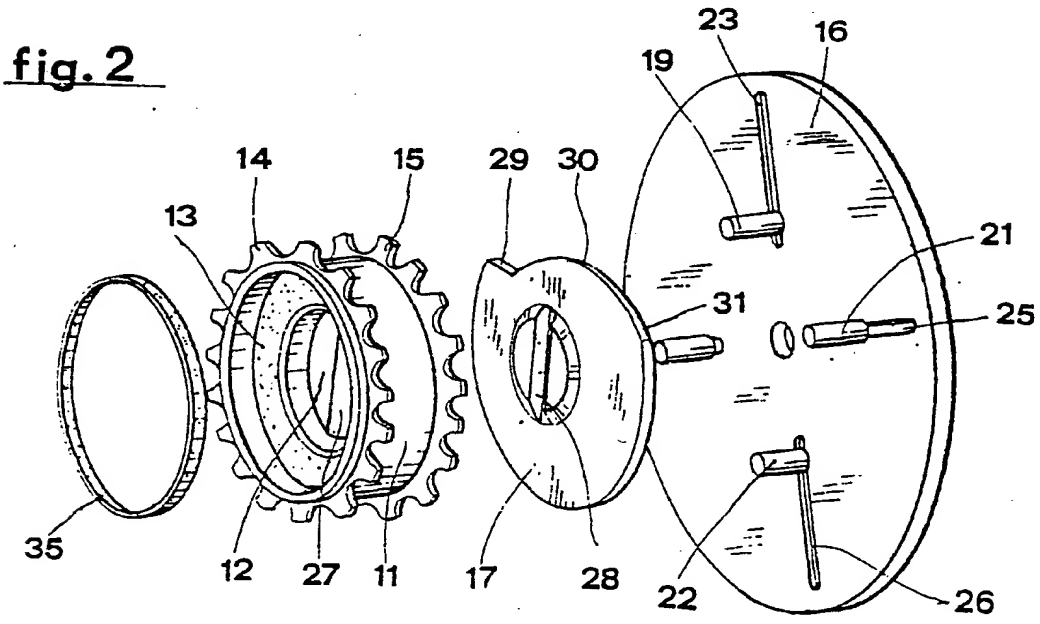
fig. 2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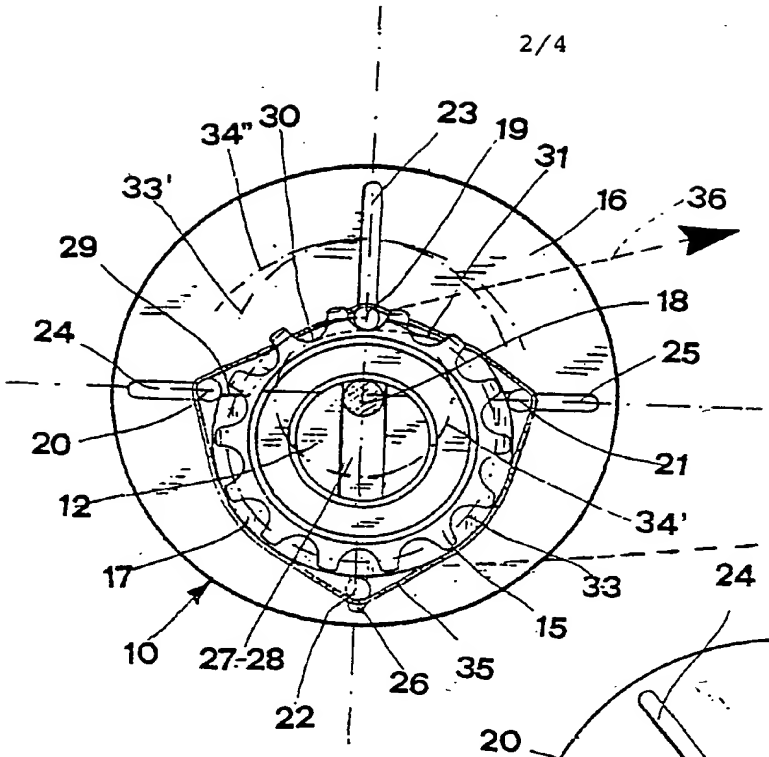

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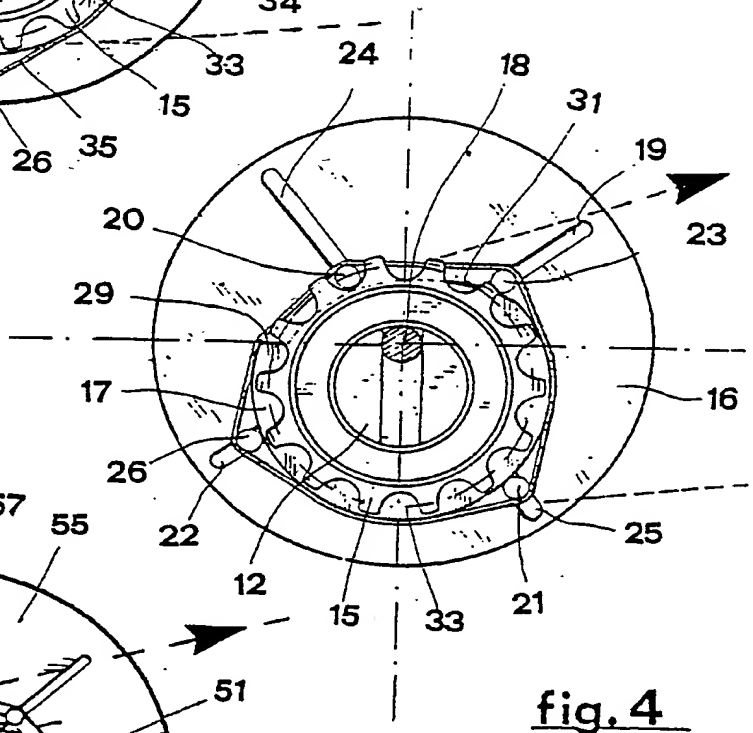

fig. 4

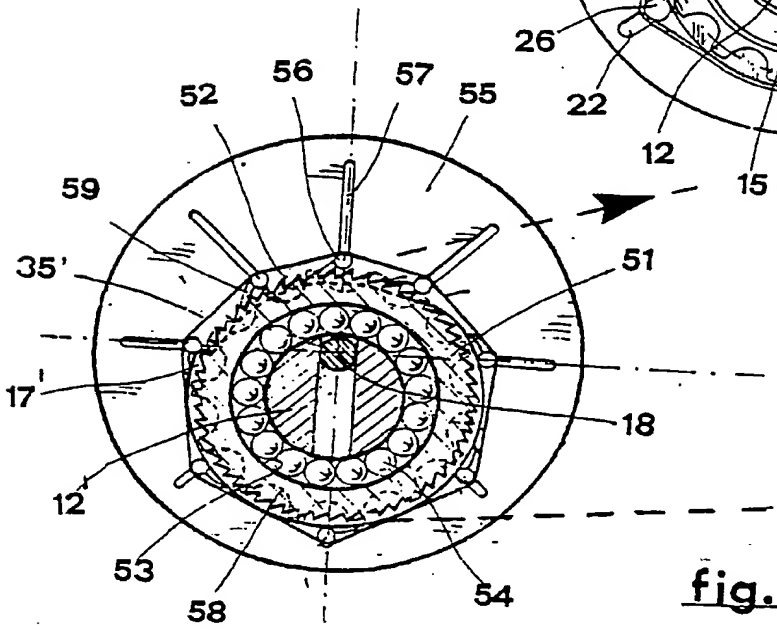

fig. 7

fig.8

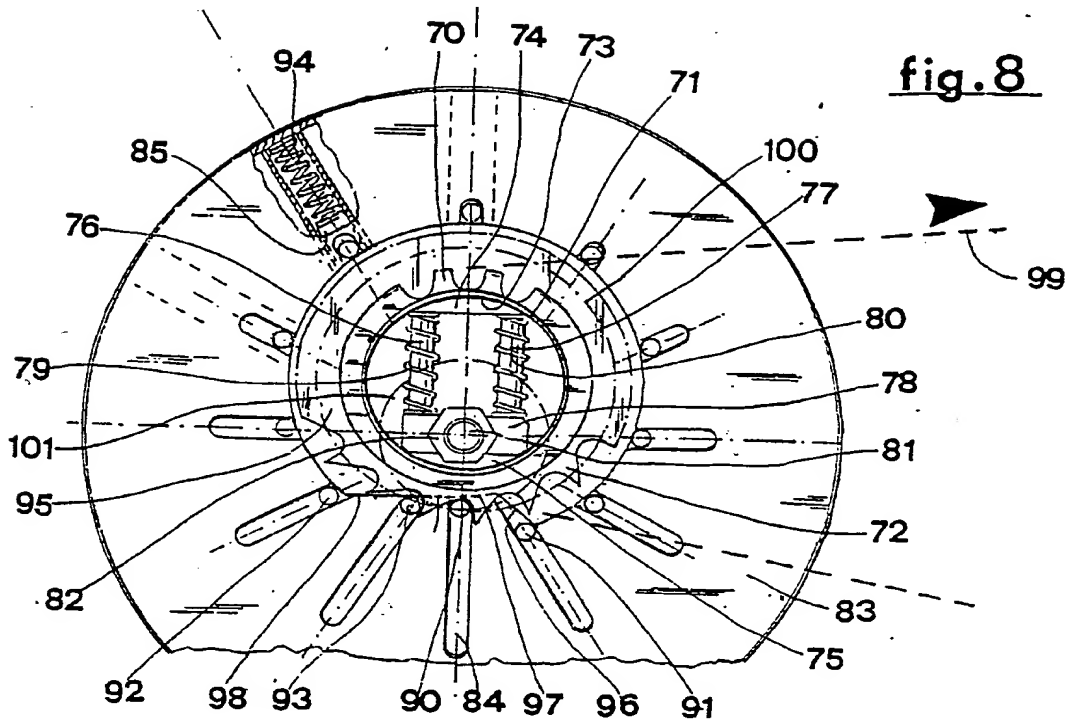
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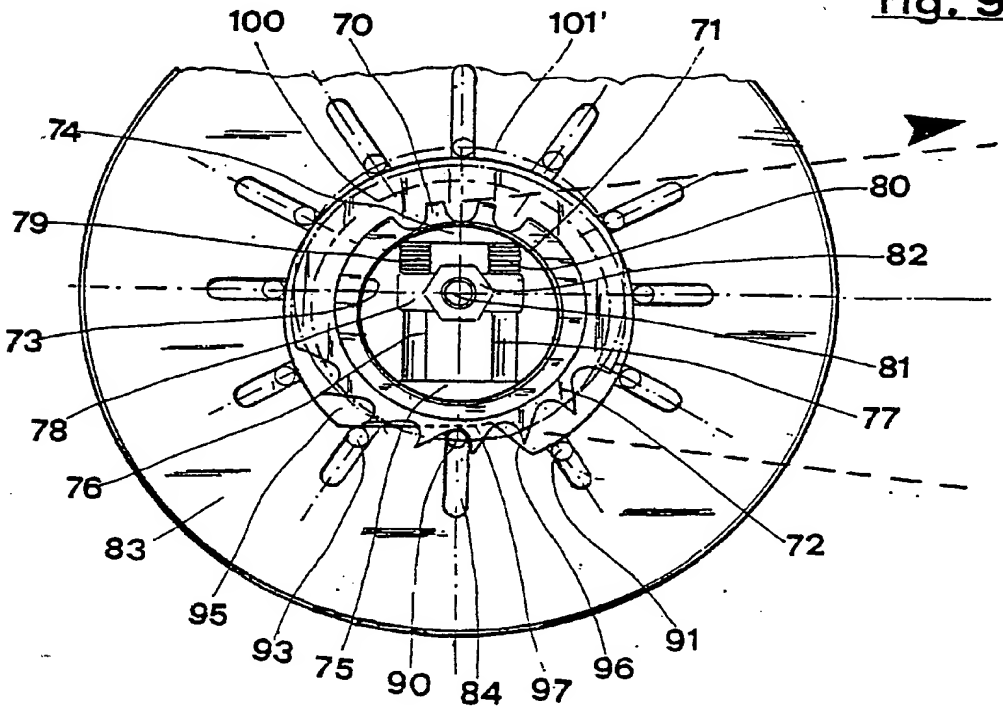
fig.9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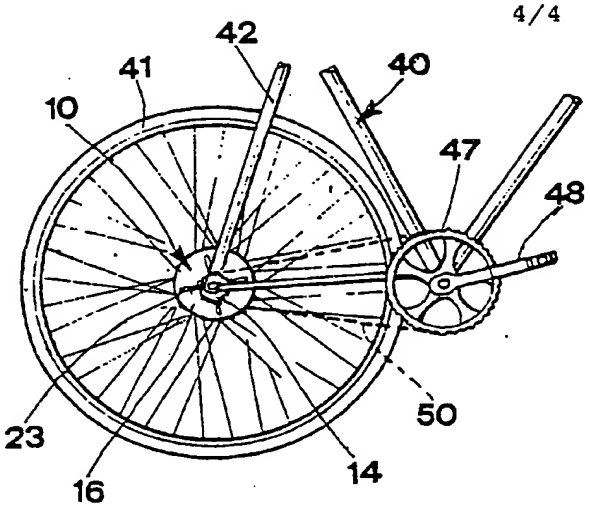

fig. 5

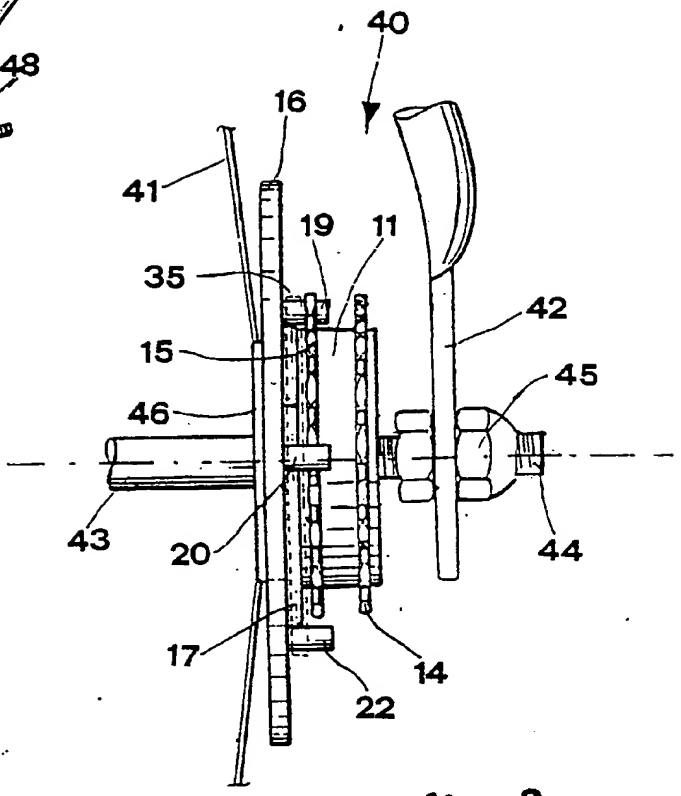

fig. 6

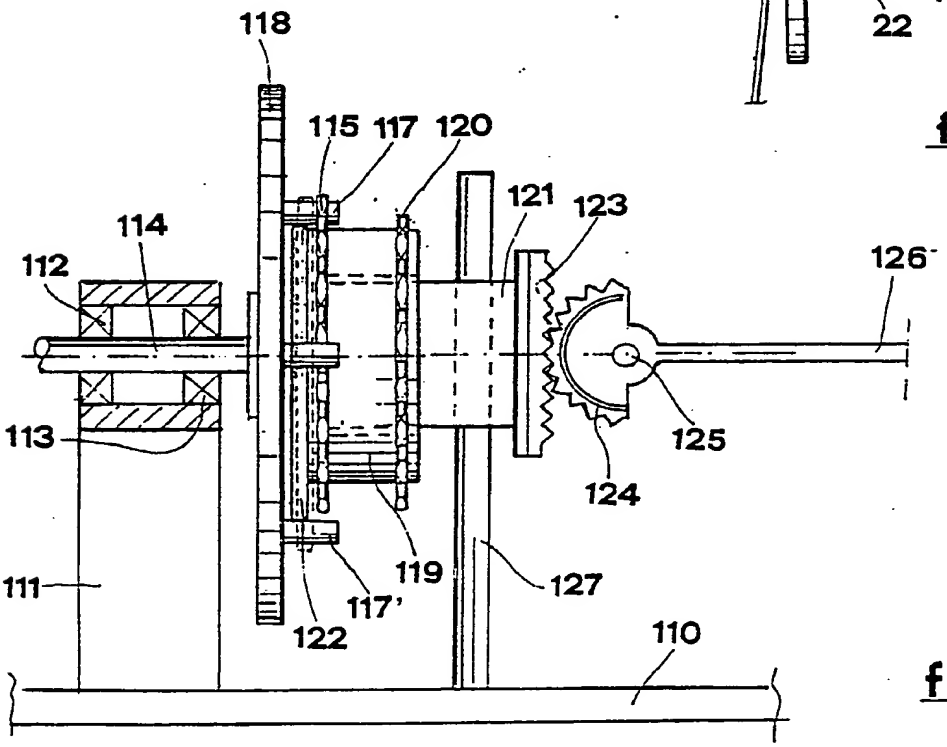

fig. 10

INTERNATIONAL SEARCH REPORT

International Application No PCT/IT 87/00001

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[4]: B 62 M 9/08; F 16 H 29/14

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[4]	B 62 M; F 16 H

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
A	DE, A, 2938013 (NANKAI TEKKO CO.) 24 April 1980, see figures 1-13; page 9, line 3 - page 16, line 23	1
A	US, A, 4129044 (ERICKSON) 12 December 1978, see figures 1-6; column 2, line 64 - column 5, line 55	1
A	US, A, 3956944 (TOMPKINS) 18 May 1976, see figures 1-6; column 2, line 5 - column 4, line 30	1
A	FR, A, 2363038 (CYCLECENTRIC CORPORATION) 24 March 1978, see figures 1-4; page 3, line 27 - page 9, line 5	1

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
24th April 1987	01 JUN 1987
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	M. VAN MOL

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/IT 87/00001 (SA 15942)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 14/05/87

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE-A- 2938013	24/04/80	GB-A,B 2035478	18/06/80
		JP-A- 55132372	15/10/80
		US-A- 4299581	10/11/81
US-A- 4129044	12/12/78	None	
US-A- 3956944	18/05/76	None	
FR-A- 2363038	24/03/78	None	

For more details about this annex :
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